Space Weather Technical Forecast

Issued on Friday, 15 April 2022 at 01:28 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: G1 Minor to G2 Moderate geomagnetic storms likely at first on day 1 (15th) due to CME magnetic cloud affects.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low with background flux rising to C1 at times. There are three sunspot regions on the visible disc, with the most developmental AR2990 Dsi/Beta, with a further uni-bipolar region following AR2989 Axx/Alpha. AR2991 Hsx/alpha is likely a mature and stable region that has recently rotated onto the southwest disc. No Earth-directed CMEs have been observed.

Solar Wind / Geomagnetic Activity: The solar wind, as observed by DSCOVR at L1, was slightly elevated at first around 420-460 km/s, however the expected CME from the filament eruption on the 11th arrived around 14/1230 UTC, increasing the solar wind to elevated 575 km/s, eventually easing back down to around 480 km/s. The density was mainly average but increased above average following the CME, peaking at 15 ppcc, easing back to average later in the period. The interplanetary magnetic field (IMF) strength Bt, was weak below 8nT at first but increased to moderate then strong levels following the CME, reaching a peak value of 22 nT. The north-south component Bz, was negative (southward) until 14/0920 UTC reaching Moderate levels of -10 nT, but then switched to positive (northward) peaking 10 nT until the CME arrived at 14/1230 UTC after which it was predominantly negative, reaching -13 nT at times. The phi angle has fluctuated but ended the period in a negative (towards the sun) orientation. Geomagnetic activity was Unsettled (Kp 3), but became Active (Kp 4) from 14/0300 UTC, with a G1/Minor Storm (Kp5) observed 14/0900-1200 UTC and 14/1800-2100 UTC. Between 14/1500-1800 UTC a G2 Moderate geomagnetic storm was observed.

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV) measured at GOES-16 at GEO was at background levels. The high energy electron flux (greater than 2 MeV) was Moderate, peaking at 772 pfu at 14/0350 UTC. The flux then dropped out 14/0420 UTC probably due to the arrival of a transient precursor to the main CME arrival. The associated 24 hour electron fluence has been below the Active threshold throughout, with observed fluence of 5.18e6 integrated pfu by GOES-16 at 14/2359 UTC.

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Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be Low. The three sunspot regions on the disc are small, and only showing limited growth, however activity from the far-side is increasingly likely to affect the Earth as it rotates near to, and onto the eastern limb.

Solar Wind / Geomagnetic Activity: Earth is within the magnetic cloud from the CME which left the Sun on the 11th, with ongoing affects forecast to last well into day 1 (15th). Enhanced solar winds are then forecast to ease before a further enhancement from the arrival of the fast wind of CH75/+ is forecast day 2 or 3 (16th-17th), although this is low confidence. No further CME arrivals are expected. Geomagnetic activity is forecast to be Active to G1 Minor to G2 Moderate Storm with any periods of notable southward pointed magnetic field that occur day 1 (15th). Mostly Quiet to Unsettled conditions returning later on day 1, but perhaps increasing to Active to G1 Minor Storm with any fast wind arrival, most likely day 2 or 3 (16th-17th). During day 3 into day 4 (17th-18th) a return to mainly Quiet conditions is expected.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to persist at background levels. High energy electron flux (greater than 2 MeV) is expected to remain suppressed day 1 and much of day 2 (15th and 16th) due to the CME arrival, but potentially rising for a time during day 2 (16th) to Moderate, perhaps peaking High. A further dropout is expected from any fast wind arrival later day 2 (16th). The associated 24 hour electron fluence is expected to remain below the Active (1e8 integrated pfu) threshold throughout, with only a slight chance of rising above day 3 (17th).

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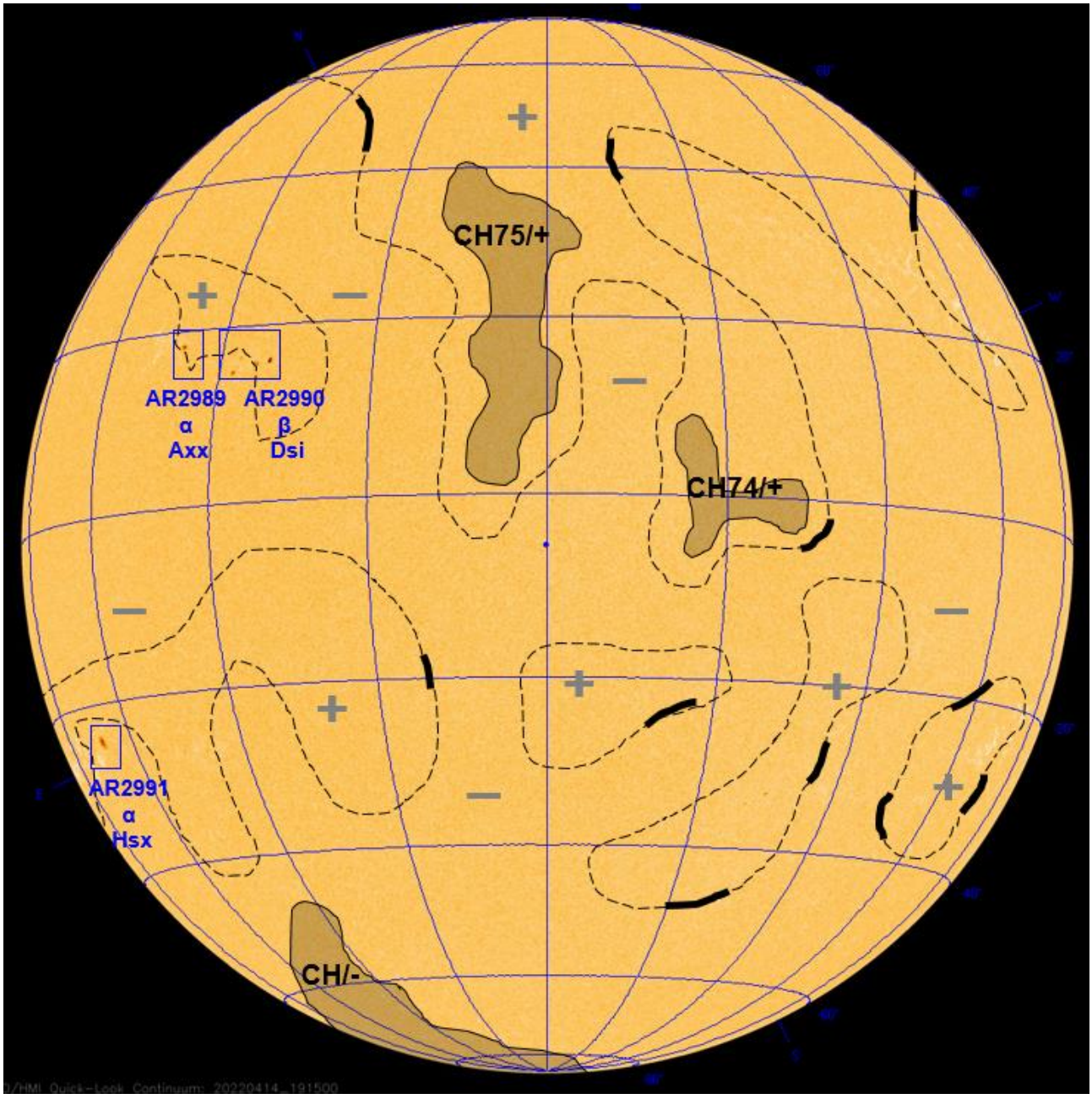
Figure 1. Solar Analysis Valid 14/1900UTC.



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Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The anticipated CME from the 11th has arrived around 14/1230 UTC, however an initial transition into its turbulent sheath region was indicated by a very limited shock at 14/0336 UTC. This has been followed by a gradual strengthening of the magnetic field. Periods of moderate negative (southward) Bz were observed after 14/1230 UTC. No further CME arrivals are expected.

These enhanced solar winds are expected to ease later on day 1 into day 2 (15th-16th), before the arrival of the fast wind of positive polarity CH74 later on day 2 (16th). The timing and strength of this feature is low confidence, with a lack no clear signal on STEREO A Mag and PLASTIC data, and also being new to this rotation, limiting the value of persistence. Furthermore, this is a positive coronal hole which is unfavoured for connection during spring (Russel-McPherron effect). Any enhanced solar winds are expected to gradually ease later day 3 into day 4 (16th-17th).

Geomagnetic activity is forecast to be Active to G1/Minor or G2/Moderate storm at first on day 1 (15th). Conditions then easing to mostly Quiet, with isolated Unsettled spells later day 1 into day 2 (15th-16th), but increasing to Active, with a slight chance G1/Minor Storm from the arrival of any fast wind from CH75, most likely later day 2 (16th). During day 3 into day 4 (17th-18th) a return to mainly Quiet conditions is expected.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	80	30	20	5
Strong	G3	No	2	2	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections- Nil

Figure 2: Updated BGS Kp indicates 2 period of G2, 14/1500-2100UTC.

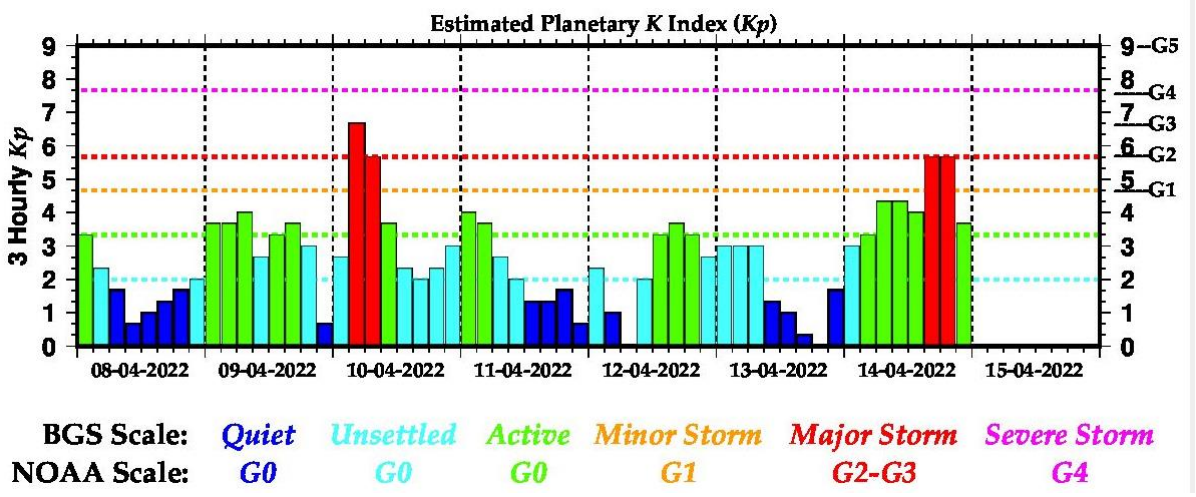

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Figure 3: The increase in the L1 solar wind speed around 14/1230UTC was the most obvious indicator that the CME had arrived.

Radio Blackouts - X-Ray Flares:

There are three sunspot regions on the disc. Whilst these are all small, and relatively simple regions with solar activity currently Low, some slight growth has been evident in AR2990 Dsi/Beta. AR2989 Axx/alpha in the northeast and AR2991 Hsx/alpha in the southeast, both appear to be a simple and stable.

The far-side remains active with recent CMEs observed, and a notable signature on far-sided products, including helioseismographs and the GONG far-side magnetograph. This corresponds to the area around Ex-AR2975 which has been traversing across the far-side, and is due back onto the east limb on the Earth-side late on day 3 (17th), and matches to a bright area of flux on visible on the STEREO A EUVI-imagery. These far-side regions, alongside development on the near-side have led to background flux levels rising. Very Low to Low activity is therefore expected, however an increase to Moderate cannot be ruled out as far-side regions approach the east limb.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	2	5	5	5
Very Active	R3 to R5 X Class	No	1	1	1	1

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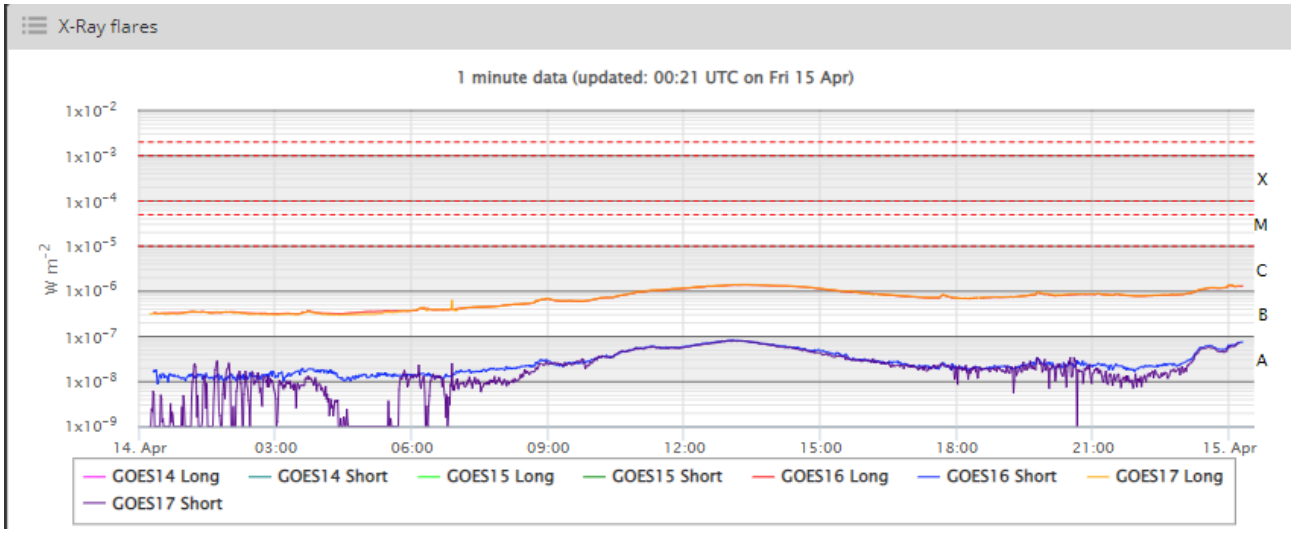
Figure 4: Background X-Ray flux is close to C1.



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as measured by GOES-16 at GEO is at background and in the absence of complex sunspots on the Earth-facing disc is expected to remain at this level.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	1	1	1
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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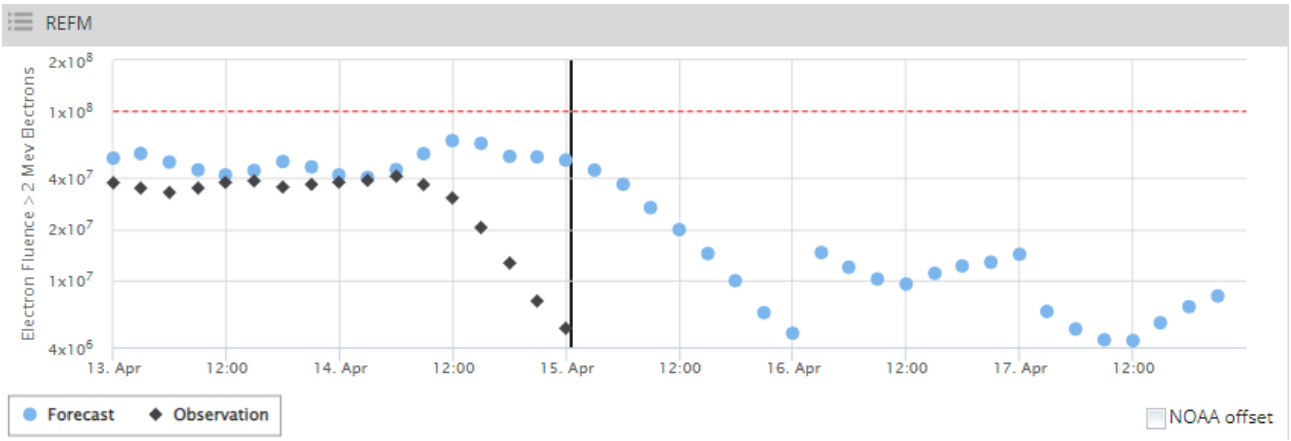
High Energy Electrons Event (≥ 2MeV):
The high energy electron flux (greater than 2MeV) as observed by GOES-16 at GEO has dropped out due to recent CME arrival. As the solar wind environment eases, the Van Allen belts are expected to relax, resulting in the observed flux at GEO to rise to Moderate, and potentially peaking at High levels on day 2 (16th). A further drop out in values is then likely later day 2 (16th), with the arrival of the fast wind of CH74, although this is low confidence in both timing and strength. A notable flux enhancement from this feature is currently considered unlikely, due to its unfavoured polarity, limited expected geomagnetic response, and the features relative immaturity with being new for this solar rotation.
The associated 24 hour electron fluence is expected to remain below the Active threshold throughout, but with a slight chance of rising above by day 3 (17th). REFM is not giving good guidance at this stage, as this currently doesn't take account of the recent CME arrival.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	10	20	10
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 5: The CME arrival caused a fairly dramatic reduction in the integrated electron fluence levels.



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